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# United States Department of Agriculture,

FOREST SERVICE.

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## DIRECTIONS AND SPECIFICATIONS FOR BUILDING TELEPHONE LINES ON THE NATIONAL FORESTS.

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Telephone lines on and near the National Forests help in their protection and administration and make the Forests more useful to the communities whose interests they are to serve. The Forest Service will build telephone lines only where they are necessary for protective or administrative purposes, and then only where there is insufficient business to warrant commercial companies in putting up lines. Commercial companies and settlers should be encouraged to build lines on and near the Forests, and the Service will cooperate with them so far as possible, with the understanding that it shall have free use of such lines for official business. For the most part the lines of the Forest Service will be branches connecting supervisors' and rangers' headquarters with exchanges of commercial companies on or near the Forests. The lines of the Service must necessarily be of simple and cheap construction at first. The main thing is to get ready means of communication. This done, the equipment will be improved as fast as possible. The usual construction will be a one-wire line on brackets attached to poles or trees. For distances up to 70 miles No. 12 B. W. G. Best-Best galvanized iron wire should be used, and for greater distance No. 9 wire should be used.

### LOCATING.

The location of the line should conform as closely as may be to the following conditions. The line should—

(1) Pass near lookout points, where they exist.

(2) Follow roads and main trails.

(3) Be direct, consistent with the above.

(4) Be hitched to trees instead of poles.

(5) Avoid steep slopes, cliffs, etc., and streams or canyons over 500 feet across.

(6) Avoid power and transmission lines as far as possible.

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If any part of the line is off the Forest, right of way must be obtained, drawn up on a regular form, which will be furnished by the Forester on request. A survey of the line may or may not be necessary. The line should be carefully laid out, however, and stakes should be set showing the location of the poles.

## ATTACHING WIRES TO TREES.

Wherever possible lines should be attached to standing trees. The course of the line may be varied considerably in order to make use

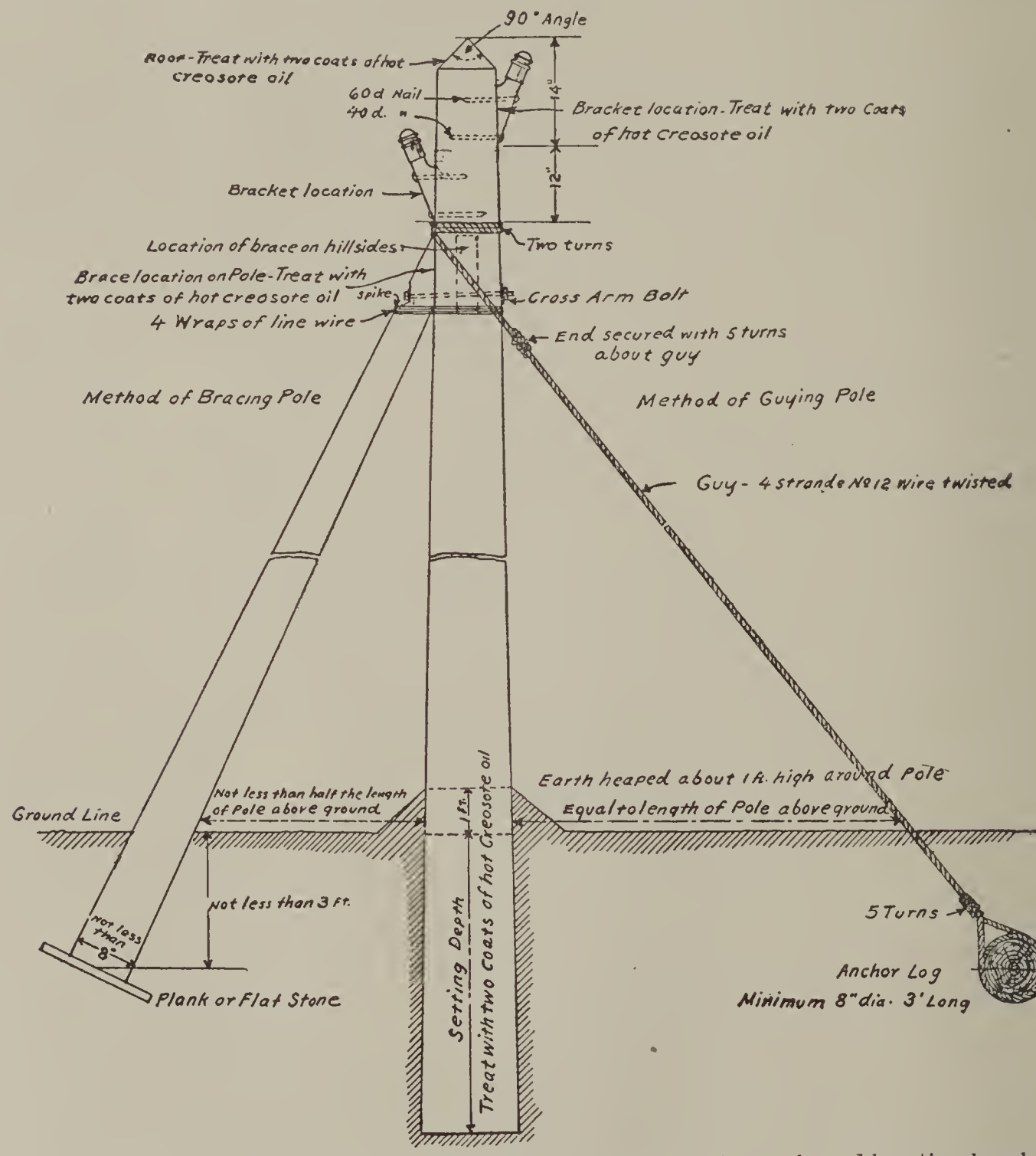


FIG. 1.—Diagram showing method of setting, guying, and bracing pole and locating brackets.

of trees where, in the opinion of the officer in charge, the cost of construction will thereby be lessened. If the tree so used is large, it should be trimmed up to 3 or 4 feet above the point where the bracket is attached; if the tree is small, it may be trimmed up to the right height to form a pole. More slack should be left in the line wire between trees than when poles are used, in order to lessen the danger of its breaking during heavy winds.

## CUTTING, SEASONING, AND TREATING POLES.

*Cutting.*—Poles should be cut near the place where they are to be set in the line. When possible poles and braces should be cut in winter or spring. They should be peeled as soon as cut and all knots trimmed close. The butts of the poles should be cut square and the tops cut slanting on both sides to form a right-angle "roof." (See fig. 1.)

*Skidding and seasoning.*—When a number of poles or braces can be collected at one point and can be distributed along the line at the time of building, without undue expense, they should be piled tier upon tier, with a space of at least 6 inches between poles in the same tier and between tiers. The bottom tier should be of sufficient height from the ground to allow of the free circulation of air under the poles. They should be seasoned at least two months and as much longer as possible.

When it is not feasible to collect poles or braces at one point they should be peeled and raised off the ground or leaned against trees or rocks in an open position to season. If sound dead timber is available, it is to be preferred, because it will not be necessary to season it.

*Treating.*—After seasoning, poles and braces should be treated with coal-tar creosote according to the following directions:[a]

Heat the creosote in an iron pot to about 175° F., being careful that the temperature does not at any time exceed 200° F. or fall below 150° F.

Apply the hot creosote, with iron-bound brushes 4 to 5 inches wide, to the outside of the pole from the butt to a point at least 1 foot above the ground line when the pole is set. Take particular pains to fill all seasoning checks and knot holes. After an interval of at least twenty-four hours the pole should be treated with a second coat, applied in the same manner. The top of the pole and the places where the brackets and braces will be attached should also be treated with two coats of hot creosote. (See fig. 1.) The preservative should never be applied when the surface of the pole is wet from rain, snow, or frost, or when the pole is frozen.

Braces should be treated in the same manner as poles and in addition two coats of hot oil should be applied to the slanting top which is fixed against the pole.[b]

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[a] Creosote can usually be bought to the best advantage through the Washington office.

[b] Under no circumstances should green timber be treated with preservatives applied with brushes to the outside, since such treatment is seldom effective and in most cases even hastens decay.

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## CLEARING RIGHT OF WAY.

A right of way wide enough for a bridle trail should be cleared when the line runs through dense underbrush or chaparral. On account of the expense of cleaning, the line should be run, so far as possible, to avoid underbrush or chaparral.

When the line runs through dense timber, either trees must be cut, or branches lopped off high enough to prevent their touching the wires. No branches or underbrush should be closer to the wire than 4 feet. All growing trees leaning toward the line, and all dead or dying trees liable to fall on the wires, should be cut.

## BUILDING DIRECTIONS.

*Length of poles.*—The standard pole will be 22 feet long, and should be used in all but special cases, where longer poles, of lengths to be determined when locating the line, should be used. In case 22-foot poles are not available, and shorter poles are, the shorter ones may be used, but only with the approval of the Forester.

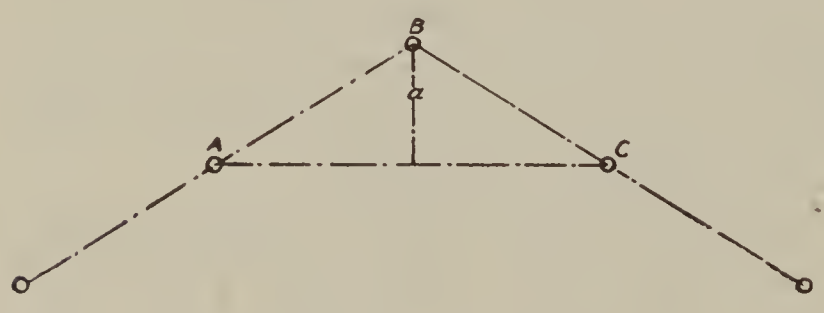


FIG. 2.—Diagram showing method of determining "pull" at corners.

The special cases where poles longer than 22 feet will be used are as follows:

(*a*) Where the underbrush exceeds 10 feet in height, use poles that will keep the lowest wire at least 4 feet above the highest brush at the middle of the section.

(*b*) Where snow is liable to drift to depths exceeding 10 feet, use poles that will keep the lowest wire at least 2 feet above the maximum depth of the drift at the middle of the section.

(*c*) Where it is necessary to grade the line to overcome abrupt changes in level.

(*d*) Where the line crosses wagon roads or railways, use poles that will keep the lowest wire at least 14 feet above the road and 26 feet above the railway at the middle of the road or track, unless otherwise required by State laws.

(*e*) At the ends of long spans across rivers, canyons, etc. Special poles or construction to be determined by the Forester will be used at these points.

*Distribution of poles.*—Place poles as near as possible to the holes where they are to be set. Poles between the minimum and average size should be used on straight sections; poles above average size should be used on curves, at corners, and at the end of long spans;

extra strong poles must be used in exposed positions and where there is danger of heavy storms.

*Spacing.*—On straight sections 30 poles per mile should be set, which will give a spacing distance of 176 feet. Where it is necessary to make any change in the direction of the line, care should be taken to make the change gradually by spreading the curve over as many poles as possible. If sharp bends are unavoidable, proper guys or braces, or both, must be provided. On curves and corners where the pull is from 10 to 30 feet the pole spacing should be 100 feet. (By the term "pull" is meant the distance *a*, fig. 2.) Where the pull is over 30 feet the bend should be made on two poles.

At right-angle corners the section on either side next to the corner pole should not be over 100 feet in length. On spans from 200 to 250 feet the last section on either end will be 100 feet.

On spans from 250 to 500 feet, two sections on either end should be 100 feet. On spans above 500 feet special construction, to be determined by the Forester, should be used.

On steep slopes sections will be so proportioned as to avoid abrupt changes in the level of the wire. Thus it follows that where crossing a ridge where the slope at the top is steep, it is better to space the poles so that one is set on each side of the summit of the ridge than to set a pole on the top. This prevents a sharp angle in the line. If necessary, use long poles to obtain the desired clearance in the span.

*Digging holes.*—On straight sections holes should be dug straight and of full size from top to bottom, so that earth thrown in the hole may be evenly tamped around the pole for the total depth of the hole. They should be dug large enough to admit the pole without stabbing or hewing, and should be of the following depths:

| Length of pole. | Depth of hole. | |
|---|---|---|
| | In earth. | In rock. |
| *Feet.* | *Feet.* | *Feet.* |
| 18 | 3½ | 3 |
| 22 | 4 | 3 |
| 25 | 4½ | 3½ |
| 30 | 5 | 3½ |
| 35 | 6 | 3½ |

On hillsides the depth of the hole should be measured from the lower side.

Where it is not possible to dig to the required depth, the pole should be securely braced or guyed, and stones and earth heaped around it and well tamped.

Where the line crosses solid rock for a distance of not more than 250 feet a span of that length may be used, but for greater distances it will probably be advisable to blast holes in which to set the poles. Where it is necessary to blast many holes, special construction, to

be determined by the Forester, may be resorted to, and instructions should be asked for before taking up the work.

In such cases consider the use of gas-pipe poles, which may be clamped to the rock and thus render blasting unnecessary.

## SETTING POLES.

On straight sections poles are to be set vertically. Corner poles are to be raked (inclined) outward from the center when set. When the "pull" is less than 5 feet the rake should be about 10 inches; when the pull is 5 to 10 feet the rake should be about 15 inches, and when the pull is over 10 feet the rake should be about 25 inches.

*Filling and tamping.*—When the pole has been set in the hole it should be "trued" and held in position while the hole is being filled

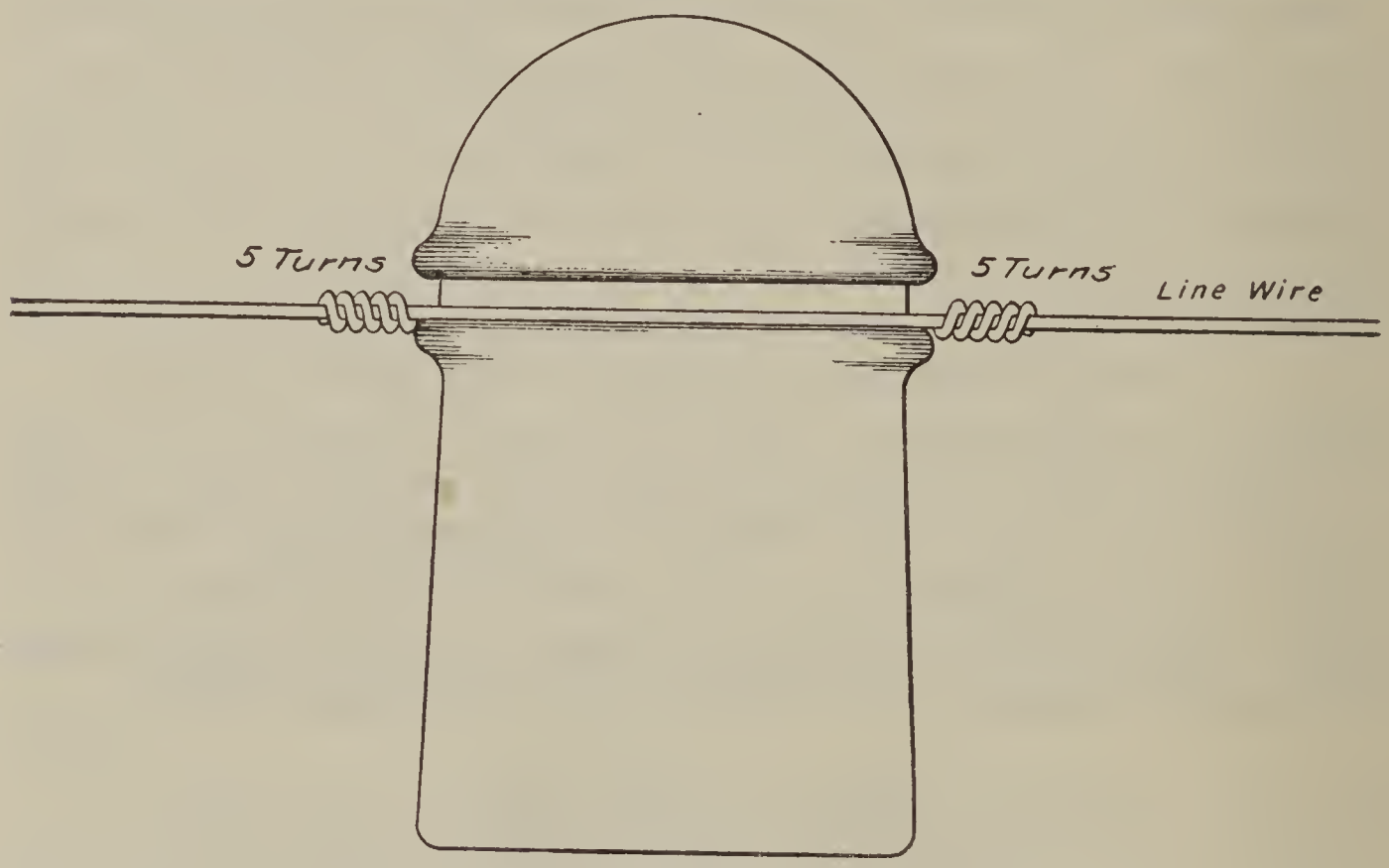


FIG. 3.—Method of tying wire to insulator.

and the filling tamped. The filling should be done by one man, and the earth firmly tamped by two men. When the hole is filled, earth should be piled about the pole and firmly packed.

*Attaching brackets.*—On one-wire lines brackets are to be placed on the same side of all poles in the line, except that a change of location may become necessary in order that all brackets at angles, crossings, or curves will be on the side of the poles away from the direction of the strain, so that there will be no tendency to pull the insulators away from the poles.

They should be nailed to the pole with one 60-penny and one 40-penny galvanized nail at the places previously treated. The base of the upper bracket should be 14 inches below the top of the pole, and the base of the lower bracket 12 inches below the base of the upper.

On straight sections of two-wire lines the brackets will be on opposite sides of the pole (see fig. 1), but on curves both brackets will be on the same side of the pole, away from the center of the curve. Brackets should be attached and insulators screwed on before the pole is erected.

*Stringing wire.*—When possible a reel containing as much wire as can be carried by two men should be carried along the line; when there is dense underbrush a coil should be carried by one man. Care must be taken that all kinks are straightened before the wire is stretched.

*Tying wire.*—Wire should be tied to insulators with tie wires of the line wire cut into 12-inch lengths, as shown in figures 3 and 4.


FIG. 4.—Method of tying wire to insulator.

Start tying from the standing end and allow the proper amount of sag between each pole. The sag of wire can be determined from the following table, taking the length of span and the temperature at the time of building. In very dry climates or where there is no great variation in temperature wire may be strung using the sag given under —10° in the table.

[Temperatures in degrees Fahrenheit.]

| Length of span. | Sag at— | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | −30 degrees. | −10 degrees. | 0 degrees. | +10 degrees. | +30 degrees. | +60 degrees. | +65 degrees. | +80 degrees. | +100 degrees. |
| | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* |
| 100 feet | 2 | 2½ | -------- | 3 | 3 | 4½ | -------- | 5½ | 7 |
| 150 feet | 4½ | 5 | -------- | 6 | 7 | 9 | -------- | 11½ | 14 |
| 175 feet | 6 | 7 | -------- | 8 | 9½ | 12 | -------- | 15 | 18 |
| 200 feet | 8 | 9 | -------- | 10½ | 12 | 15½ | -------- | 19 | 22½ |
| 250 feet | 14 | 16 | -------- | 18½ | 21 | 26½ | -------- | 31 | 36 |
| 300 feet | 22 | -------- | 27½ | -------- | 33 | -------- | 44 | -------- | 55 |
| 350 feet | 31 | -------- | 39 | -------- | 46 | -------- | 61 | -------- | 76 |
| 400 feet | 43 | -------- | 52 | -------- | 60 | -------- | 78 | -------- | 96 |
| 450 feet | 58 | -------- | 68 | -------- | 78 | -------- | 96 | -------- | 120 |
| 500 feet | 72 | -------- | 84 | -------- | 96 | -------- | 120 | -------- | 150 |

For spans up to 500 feet the line wire may be used. Where spans of over 500 feet occur, instructions from the Forester should be asked for in advance, in every case giving the length of span re-

quired and the approximate height from water surface of river or bottom of canyon to a straight line between supports.

*Joining wire.*—Iron wire should be joined by making a standard Western Union joint, as shown in figure 5, or in lines exceeding 50 miles in length by the use of McIntyre sleeves.

*Bracing and guying.*—Braces are preferred to guys and should be used whenever possible. Braces or guys should be used on poles in the following positions:

(*a*) On curves or at corners where the pull exceeds 30 feet.

(*b*) At road crossings.

(*c*) The two end poles of spans between 200 and 250 feet.

(*d*) Two poles on either end of spans between 250 and 500 feet. (Special construction, to be determined by the Forester, should be used at the ends of spans over 500 feet.)

(*e*) All poles on steep slopes where short sections are used. Anchor guys may be preferably used in these cases, or a head guy from the top of one pole to the base of the pole next above it may be used.

(*f*) Alternate poles in exposed positions.

(*g*) In swamps or on loose ground where necessary.


FIG. 5.—Method of joining wire.

(*h*) Poles on either end of power or transmission line crossings. (Special construction, to be determined by the Forester, should be used where telephone lines cross under or over power or transmission lines.)

Braces should be at least 8 inches in diameter at the butt, and should be cut slanting at the top to fit close to the pole; but the pole must not be cut. They should be set at least 3 feet in the ground, with the butt end resting against a flat stone or a plank. They should be attached to the poles with a cross-arm bolt having a washer at each end, as shown in figure 1. This bolt should be at the lowest point of joint. If necessary, notch the brace in order to get it in the location. Never cut the pole.

Guys should be made of four pieces of the line wire twisted together, and should be sufficiently long to reach from the top of the pole to the ground at a distance equal to the height of the pole above ground. Guys should be attached to poles at a point immediately under the lower bracket by making two turns around the pole and wrapping the end five times around the guy. The turns should be secured by three 2-inch galvanized-iron staples. The other end of

the guy should, if possible, be attached in the same manner to a tree trunk in the opposite direction to the pull, otherwise to a log not less than 8 inches in diameter and 3 feet long and buried at least 3 feet in the ground.

*Lightning rods.*—Lightning rods, to be placed on the pole before erection, should be made of one piece of the line wire of a length sufficient to reach from 3 inches above the top of the pole to the bottom of the pole. The rod should be held in place by 1-inch galvanized-iron staples, and so placed that it can not come in contact with the line wire, should the latter become detached from the insulator. The best location is one-fourth of the distance around the pole from the bracket, for if put on the opposite side from the bracket the line

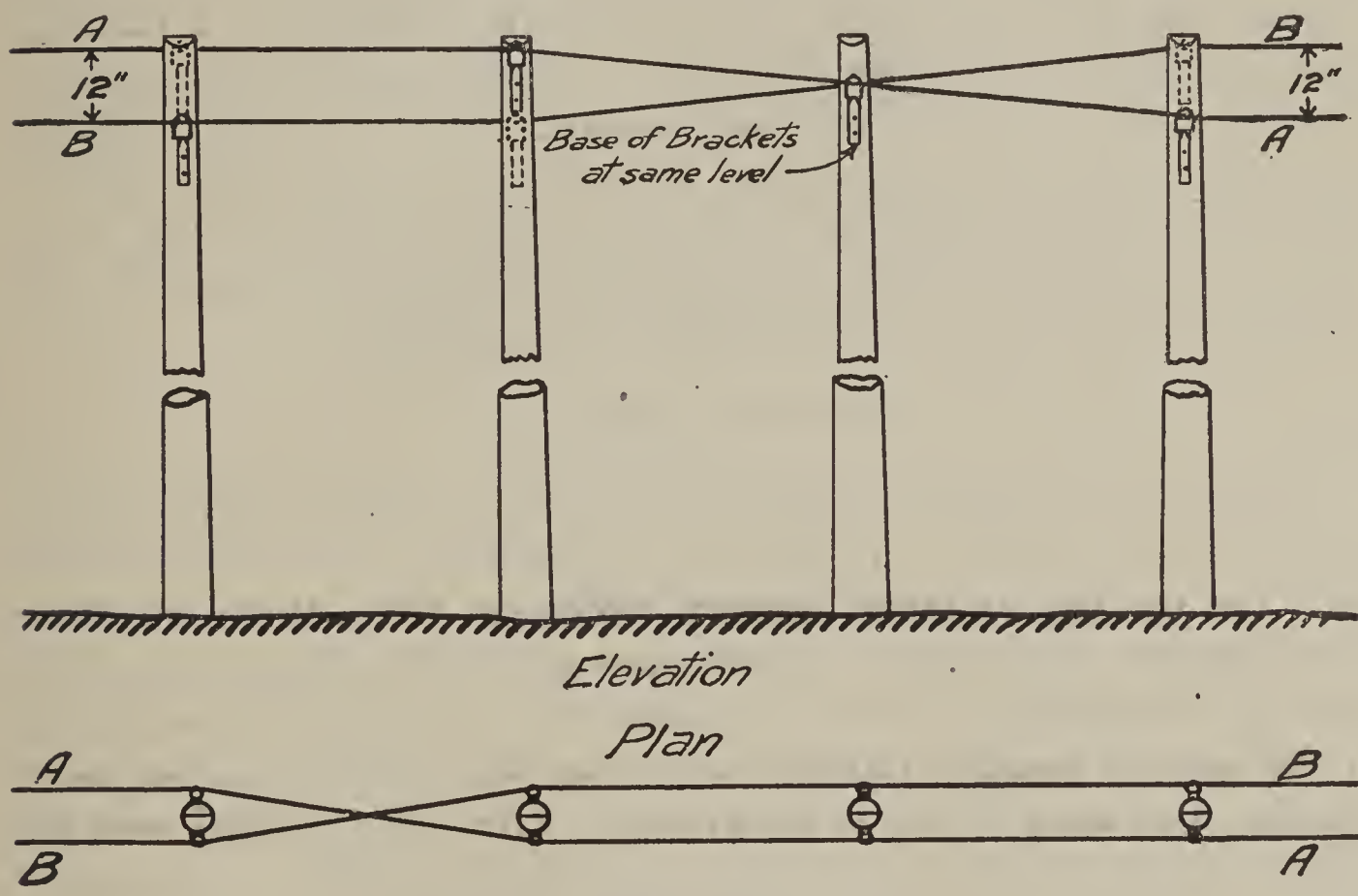


FIG. 6.—Transposition of wires.

wire, should it be thrown to that side of the pole, would touch it, thereby grounding the line.

Lightning rods will be placed upon every tenth pole where the line is in the open exposed to frequent thunderstorms. In ordinary situations every twentieth pole will be equipped with a lightning rod.

## TRANSPOSING.

When a two-wire line is built the wires should be transposed every thirtieth pole, unless the line parallels or is in the vicinity of a high-tension power line. In such cases transpositions should be made every fifteenth pole, or oftener if necessary. By transposing is meant the changing of the location of the wires, as shown in figure 6.

## GROUNDING.

Great care must be exercised in building a ground circuit to obtain a good "ground." One of the greatest sources of trouble on telephone lines is a bad ground. Dry earth is not a conductor, and contact must therefore be made with moist earth. The ground wire must be so deep in the ground as to be below the freezing point and below the point where the ground dries out in summer. Dry ice is an excellent insulator, and a grounded wire in frozen earth is absolutely worthless. Weak ringing and faint talking will frequently be caused by bad grounds, and often this difficulty is wrongly attributed to faulty bells or transmitters. A dug well is an excellent place to terminate a ground wire. The pipe of a deep driven well also makes a good ground, but the best ground can probably be obtained in a running stream if there is one close at hand. In connecting the ground wire to the ground rod see that it is well soldered. In connecting an instrument with the line wire, brighten the wire before soldering. Where with two or more grounded circuits running parallel to each other there is an excessive amount of cross talk, it is safe to assume that the ground on one or more of the telephones is imperfect.

## LIGHTNING ARRESTERS.

Lightning arresters should always be placed between each instrument and the line wire, to prevent the instrument from being burned out. On the top of many modern telephone boxes there are three binding posts. The right and left ones are for making the line and ground connection in the case of ground circuits, and line connections in the case of metallic circuits, and from the middle post an independent wire must be run to the ground. This is the ground wire for the lightning arrester, and over it the lightning bolt or the sneak current passes to the ground. Sneak currents are caused by power wires or other electric conductors crossing the telephone line. If either a sneak current or bolt of lightning enters a telephone apparatus, the wires are overheated and the insulating material is burned off, thus rendering the coils useless and putting the instrument out of service. There are many forms of lightning arresters on the market, but all are designed for the one purpose of short-circuiting a current of high amperage before the current reaches the telephone apparatus.

Where a metallic circuit is employed carbon blocks offer sufficient protection, but where a grounded circuit is used they offer no protection whatever. It is therefore necessary on a grounded circuit to use some form of lightning arrester provided with a fuse which is burned out in case of excessive currents, and to place a lightning arrester between the fuse and the line.

As it is very essential that every instrument should be amply protected, supervisors who can not obtain reliable information locally regarding the installation of lightning arresters should immediately inform the Forester, and the necessary information will be furnished.

Each instrument should be provided with a sufficient number of new fuses to replace burned out fuses. In case a fuse is burned out and no new fuses are available, the fuse block may be "bridged" temporarily with a piece of wire if it is desired to use the instrument. In this case the supervisor or exchange operator should be immediately notified.

### INSPECTION AND TESTING.

A regular inspection of the whole line should be made every month during the season of fire danger, and two inspections should be made at equal intervals during the remainder of the year. The person making these inspections should call terminal stations of the Forest Service line from each substation to test the instruments and connections.

Special inspections of the line should be made in each district by the ranger, or other officer in charge, immediately after severe wind, snow, or electrical storms, and after fires.

Rangers, forest guards, and others of the Forest force should examine the line wherever it is encountered during the discharge of their regular duty. They should also test the line every morning, if possible, to be sure that it is in working order.

### EMERGENCY REPAIRS.

Each member of the Forest field force should keep on hand at his headquarters 200 to 300 feet of line wire, 6 brackets, 6 insulators, and a supply of nails, staples, etc., to be used for the temporary repair of breaks. He should carry a small quantity (10 to 20 feet) of wire at all times while on patrol or inspection duty, in order to repair immediately any breaks in the line.

### RECORDS.

For each new piece of line built records should be prepared and submitted with the annual report, or at such times as the Forester may require. These records should be made in the following form:

POLE-LINE CONSTRUCTION.

*Report for the year 19____.*

_____ National Forest.

Name of line_____

Length of line_____. Size of wire_____

Construction begun_____. Finished _____

Kind of timber_____. Length and size of standard pole_____

Cost, total and per mile_____

Stations installed:

| OFFICIAL. | PRIVATE. |
|---|---|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

Report by _____

Official title _____. Date _____

SPECIFICATIONS.

*Poles.*—All poles should be cut from sound dead or live trees, and should be free from rotten knots and other defects which would weaken the timber. They should be reasonably straight, peeled, with branches trimmed close, and of the following sizes:

| Length. | Top diameter. |
|---|---|
| *Feet.* | *Inches.* |
| 18 | 5 |
| 22 | 5 |
| 25 | 5½ |
| 30 | 6 |
| 35 | 6 |

*Brackets.*—Twelve-inch painted oak brackets conforming to specification of the American Telephone and Telegraph Company should be used.

*Wire.*—Galvanized iron wire, quality B. B., conforming to specification of the American Telephone and Telegraph Company, should be used, excepting on long spans of over 500 feet, where special instructions from the Forester should be asked for by the supervisor or man in charge of telephone work.

*Insulators.*—Line insulators of the type known to the trade as "Standard Pony" insulator, conforming to specification of the American Telephone and Telegraph Company, will be used. Wire, insulators, and brackets should be requisitioned through the Washington office. Authority to purchase locally will be given the supervisors only in exceptional cases.

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